



Impact of macroeconomic announcements on electricity price

Thomas Antoniadis

SID: 3303150001

Supervisor: Dr. D. Psychoyios

SCHOOL OF SCIENCE & TECHNOLOGY

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Abstract

This dissertation was written as part of the MSc in Energy Management at the International Hellenic University and investigates the impact of macroeconomic announcements on electricity prices. From the beginning, the main problem was the absence of previous literature review focused on this topic. However, it was an incentive for me and my supervisor Dr. Dimitrios Psychoyios for further examination about the topic.

As macroeconomic announcements are used the FOMC meeting news and the CPI and PPI reports (from Federal Reserve Bank), while the electricity prices regard the one day ahead prices from the New York Independent System Operator (NYISO). The regression analysis contains an ordinary least squared (OLS) model, giving as a result an evidence that the electricity prices are affected from the announcements. Afterwards, the thesis closes trying to interpret an association between the regression results and the literature review and is given an explanation about the prices influence from the macroeconomic news.

Thomas Antoniadis

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Introduction

The current dissertation topic focuses on the examination of the one day ahead electricity price influence from the macroeconomic announcements. The combination and the interaction of these macroeconomic announcements with the commodity prices have, already, attracted the interest of many scientists, such as economists, engineers and statisticians. There are many scientific working papers which try to indicate the association between the macro shocks and some financial indices. The main reason for this effort, is that the research not only applies to a quantitative econometric analysis, but also regards, heavily, power supplies and commodities which have a leading role in the industrial field.

For this purpose, the one day ahead electricity prices are investigated around the Federal Reserve System's FOMC meeting days and around the consumer price index (CPI) and producer price index (PPI) reports.

The Federal Open Market Committee (FOMC) consists of twelve members in total and fulfils eight scheduled meetings per year. However, unscheduled meetings can be held when it is considered necessary by the committee. From the twelve members, seven of them are the Board of Governors of the Federal Reserve System, one member is the president of the federal bank of New York, while the other four members are presidents of the remaining federal banks of the USA. The objects of these meetings are the economic and financial condition reviewing, the monetary policy determination and the price stability as well as the sustainable economic growth risks assessment. The minutes of FOMC meetings are released three weeks after the meeting day and the policy decision.

In addition, CPI and PPI reports are significant macroeconomic indicators, which are used by many investors, and it seems that they have a major effect on asset and commodity pricing [Christie-David et al., (2000)]. The two indexes give severe information about the monetary policy of a country and describe the economic growth or recession.

For that reason, the macroeconomic announcements which have been presented at this dissertation, have been chosen according to previous scientific papers, in which is investigated the macro announcements impact on the commodity prices or on the stock market bonds, uncertainty and exchange rates. At these working papers both FOMC meetings and CPI and PPI indexes, have a significant effect on the amounts that have been mentioned before. [Fleming and Remolona, (1999); Nikkinen and Sahlstrom, (2004); Sarri, (2015); Chen and Clement, (2007); Belgacem et al., (2014); Andritzky et al., (2007); Barnhart, (1989); Chatrath et al., (2012)]

The dissertation roadmap consists of seven (7) sections. Section 1 is the introduction that has, just, been presented, while section 2 focuses at the literature review and the previous scientific papers regarding the topic. The dissertation continues with Section 3, giving information about the data set which is used and the methodology which is applied, whereas at the same part are presented the calculations and the results of the regression analysis. Afterwards, follows the empirical discussion about the results, trying to investigate a possible association with a literature review (Section 4). The thesis concludes at Section 5 and closes with Section 6 and Section 7, which represent the references and the appendix part of the topic.

Literature Review

One of the most significant problems during this dissertation is the absence of previous working papers relevant to the electricity price response to macroeconomic news. However, it is an incentive for further investigation about the topic.

Most of the papers have focused on assets, bonds, stocks, foreign exchange rates and, generally, the financial markets. Chen et al., (2013) working sheet, following up on the US stock futures for the macro news importance investigation, notes a significant impact both on the level and the volatility of returns. Balduzzi et al., (2001) and Becker et al., (1996), consider US Treasury bond (T-bond) prices and show a severe interaction between the prices and the inflation and employment rates. Anderson et al., (2003) investigate the interaction between the US dollar against six foreign currencies and the macroeconomic news, Cai et al., (2009) measure the exchange rates interaction with macro news in nine emerging markets, while Galati and Ho, (2003) and Ehrmann and Fratzscher, (2005) examine the impacts on the euro-dollar exchange rate. All the papers above, report a significant effect on returns and volatility from the US macroeconomic announcements. Donders and Vorst, (1996), Nikkinen and Sahlstrom, (2004) and Fleming and Remolona, (1999), note that the financial asset price volatility is greater around the scheduled meeting days than the corresponding price during the days that there is no news release. Especially, Nikkinen and Sahlstrom support that volatility increases before the announcement and drops after the news, while at the same paper is noted that both the CPI and the PPI indicators are significant. In addition, Donders and Vorst report that the implied volatility has the maximum value the day before the announcement. A similar result occurs from Dubreuille and May, (2009) research, in which is investigated the US announcements impact on foreign markets, trying to determine the world economy behavior. At this working paper is noted that the European stock market volatility doubles five minutes after a US macroeconomic announcement. Moreover, more than twenty years ago, Ederington

and Lee, (1993) showed that the interest rates and the foreign exchange rates are significantly more volatile the announcement days.

The electricity prices effect is a topic that, as it seems at the literature review, has not been investigated before. Knittel and Roberts, (2005), highlights that, although, there is a significant amount of investigations on commodity prices , the relative youth of electricity market restructuring, lead to the absence of research focusing entirely on electricity prices. For that reason, during this dissertation the electricity price is assumed and confronted as a commodity price.

A brief review at the commodity and electricity price theories is necessary and helpful to understand the price response to macroeconomic surprises. As it is stated in Hardouvelis, (1987) working paper, an interest rate increase leads the speculators and the traders to their portfolio adjustment, considering their advantage of lower risk bonds and higher yielding. For that reason, commodity, stock and foreign currency prices tend to become fewer when the interest rates increase from the macro announcements. Another fact which affects the commodity prices is the problem with the commodity storage. It is widely known that the costs of storing have a significant impact on the commodity prices. Thus, a macro announcement for an interest rate increase, has as a result the raise at the commodity cost of storing and, simultaneously, the decrease at the inventory demand from the traders and the distributors [Chatrath et al., 2012]. Both Bond, (1984) and Chambers, (1985), who have examined the interest rates impacts on the commodity prices, note that the falling demand tends to affect negatively the commodity prices, because more of the commodity is leading to the energy market rather than remain in storage.

In addition, a very important and useful paper about the examination of the electricity markets and, especially, of the electricity prices, was published in 2005 by Knittel and Roberts. Firstly, the two researchers confirm the suggestions by Bessembinder and Lemmon, (2002) that both power prices and price volatilities, contain a positive skew which

is associated with the demand variability. This skew is larger the high demand periods and smaller the periods of low demand variability. Moreover, it is noted that electricity price volatilities have different behavior depending on the sign of the price shocks, since a positive shock tends to raise the price volatilities more than a negative one. The same paper continues reporting the discrepancies at the electricity prices between the weekdays and the weekends, presenting the results at the following figure, (figure 1).

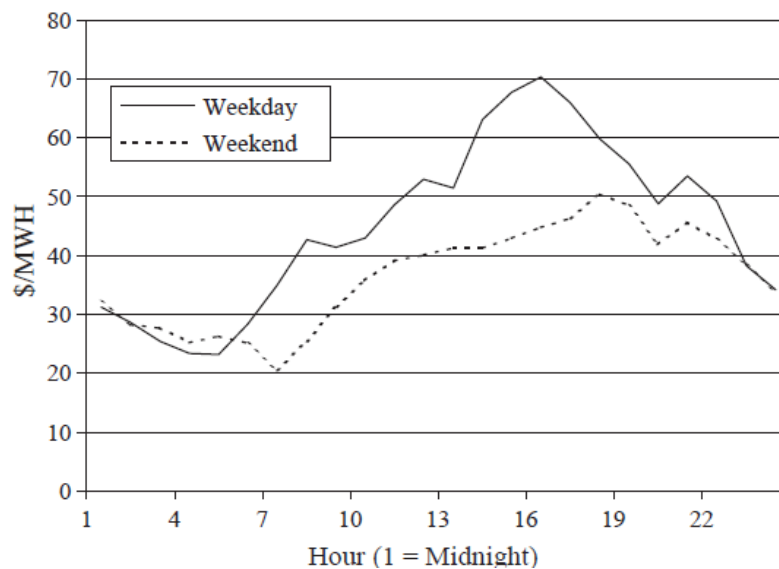


Figure 1: Average hourly electricity prices (\$/MWH), on weekdays and weekends

[Knittel and Roberts, (2005)]

From the figure above, it is quite clear that during the weekdays, when the electricity demand is greater, the electricity prices are on average higher, with a peak at 4:00 pm. Furthermore, Knittel and Roberts declare the existence of seasonal patterns at the prices at quarterly level, because of the electricity demand seasonality, noting that the prices are higher during summer when the air conditioning is needed.

Another term which is worthwhile to be analyzed, briefly, at this point of time is the price volatility. As it is mentioned before electricity price volatilities depend on the sign of the price shock. Higgs and Worthington, (2008), at their paper about the Australian

wholesale electricity market, note that electricity is among the most volatile of the commodities. The previous statement is, highly, supported by a report from US Federal Energy Regulatory Commission, (2004), in which are compared the annualized historical volatilities of the electricity market with the natural gas and oil prices. This report concludes stating that electricity price volatility approach 300%, while oil and natural gas price never exceed 100%. Furthermore, Janczura et al., (2012), at their research about spikes and seasonal components at electricity spot prices, measure that the electricity price volatility is up to 50%, while it is mentioned that even very volatile stock not exceed 4%. The high volatility levels at the prices are, also, stated by Fanone et al., (2013) at the research about the negative day ahead electricity prices, while Ciarreta and Zarragab, (2016) report that the nature of the electricity day ahead markets create significant volatility in the wholesale electricity price. Another investigation by Dan Werner, (2014), confirms all that has, already, been mentioned above. Werner supports, heavily, that high volatility levels were imported at the wholesale electricity prices due to restructuring of the market and the creation of major implications for trading risk reduction. In addition, his paper confirms Knittel and Roberts, (2005), since it is proved the existence of association between the electricity price volatility and demand, (Figure 2).

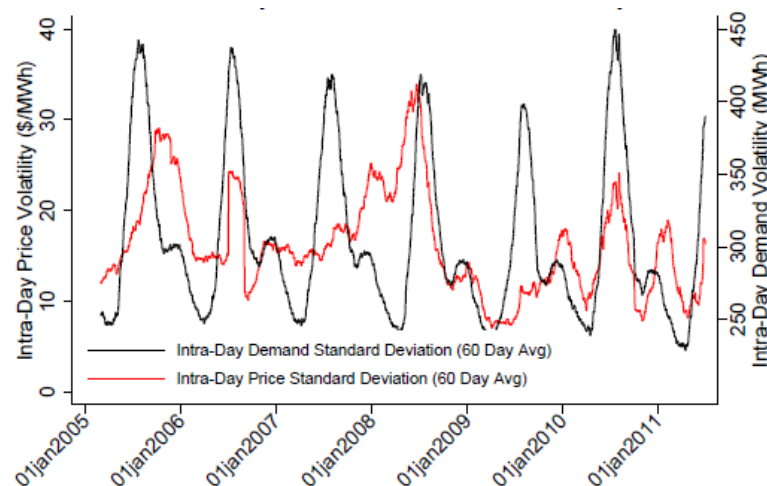


Figure 2: Intra-day Price and Demand Volatility

[Dan Werner, (2014)]

The literature shows that there are limited working papers in which is investigated the macroeconomic announcements impact on commodity prices. According to these reports, there is a significant association between the commodity prices and some macroeconomic indices. Christie-David et al., (2000) note and prove the existence of a strong effect on gold prices the days that there is news about the CPI, GDP and the PPI. A recently research, a few years ago, by Elder et al., (2012) reports a negative effect on gold and silver prices, when there is an announcement about an unexpected improvement in the economy. Moreover, Smales et al., (2015), examining the impact on gold future prices, interpret a significant influence on gold market from major macroeconomic announcements, investigating the volatility and the returns from the market activity. According to Hess et al., (2008), the macroeconomic announcements impact on the commodity prices is different during a recession period than the effect during an economic expansion. Especially, at a recession period, announcements such as CPI have a significant reaction on commodity prices and they are related positively with them. In contrast, the same paper reports the absence of a price influence during an economic expansion. Moreover, Roache and Rossi, (2010), assessing the commodity prices response to macro news over daily frequencies, note that most of the commodities interpret an insensitive tension to the news. The two researchers complement a different sensitivity regarding the type of news. The results at their working paper indicate a significant asymmetry for some commodities between good and bad news. Most prominently, both gold and natural gas prices seem to be affected from bad news much more than from good news.

Kilian and Vega, (2008), end up at a different result, finding that there is no evidence of significant effect on crude oil and gasoline prices and they reject the hypothesis that prices respond to the macroeconomic aggregates. Chatrath et al., (2012) support, strongly, Kilian and Vega, reporting that crude oil prices are predetermined to macro aggregates. However, there is something common between the working papers which have been presented above. All the studies, agree that both commodity volatility and returns are not

affected by the macroeconomic releases. Nonetheless, there are ambiguous results regarding the US macro news impact on commodity prices.

A very important part for a scientific research is the regression analysis and the models which are applied by the inventors to understand and indicate the relation between two or more variables. Thus, it is worth noting the methodologies which are concerned at the working papers above.

There are two fundamental models which are widely used at the literature review and try to investigate the relationship between a dependent variable (Y) and one or more independent variables (X). The first one, which is, also, going to be applied at this dissertation topic, is the Classic Linear Regression Model (CLRM) and the Least Squares Regression (LSR). This model is divided into two sub categories, the linear or ordinary least squares (OLS) and the non-linear least squares. The difference between the two sub-models depends on the residuals linearity. OLS is a method which targets at the unknown parameters estimation in a classic linear regression model and purposes to the minimization of the sum of squares of the differences between the values of the data set and the predicted values by the linear approximation of a set of explanatory variables. The smaller the discrepancies, the better the model.

The ordinary least squares model is being described from the formula below:

$$y = a_0 + a_1x \quad (\text{eq. 1})$$

where,

a_0 : the intercept of the model which indicates the value of the dependent variable when the value of the independent value is equal to zero

and

a_1 : the slope coefficient of the model.

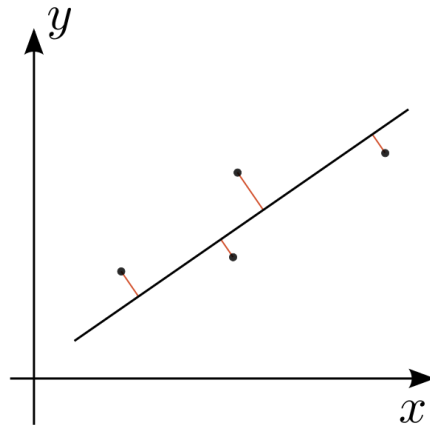


Figure 3: The ordinary least squares (OLS) regression.

The lengths of the vertical red lines are the residuals.

The smaller the distance, the better the model

The analysis which is presented above, constitutes a standard and worthwhile approach for the researchers' majority. Nikkinen and Sahlström, (2004) use a simple regression model to investigate the macro announcements impacts on VIX returns, while Chen and Clements, (2007) apply the same methodology for the S&P 500 implied volatility research. Both Cai et al., (2009) and Hardouvelis, (1987) run an OLS model at their researches too. In addition, the least squares regression model is used by Fleming and Remolona, (1999) to estimate the announcements impacts on Treasury yields, while a same ordinary model is applied by Barnhart, (1989) investigating the effects on commodity prices.

The second model, which is applied by many researchers at the literature review, is the Generalized Autoregressive Conditional Heteroskedasticity model or GARCH model. This methodology is widely used in financial applications and has been proved its satisfactory outcome at the volatility changes prediction. In addition, GARCH model states

the squared errors time evolution and the extent of uncertainty evolution and according to the financial theory the uncertainty affects the volatility. [Sarri, (2015); Robert Engle]

The majority of the inventors who desire to investigate the impacts of macroeconomic announcements at financial indices, use the GARCH model at their working papers. Donders and Vorst, (1996), apply the generalized autoregressive conditional heteroskedasticity model at their research on implied volatilities. Furthermore, the same model is used by Belgacem et al., (2014) at their investigation about the volatility spillovers. A close methodology is used by Hess et al., (2008) at their working paper about the commodity futures effect from the macro news, while both Smales et al., (2015) and Andritzky et al., (2007), apply a GARCH model examining the announcements impacts on gold futures and emerging market bonds, respectively. Roache and Rossi, (2010), who estimate the effects of macro news on commodity prices, report the existence of heteroskedasticity and high and low volatility periods at the data set and for this reason they prefer the GARCH model than an OLS regression.

Another important and remarkable part for every scientific investigation is the choice of the preferable data set. Regarding the electricity prices, there are two kinds of data at the electricity trading system. The two different data sets are the intraday and the one day ahead data set, which are used at the intraday market and the one day ahead market respectively.

The term “intraday” or “within the day” price refers to a commodity trading agreement which opens and closes at the same trading day, while the “one day ahead” to the commodity transaction in which the delivery of the power is completed the following day of the price agreement. The main advantage of using intraday market is the absence of impacts from possible negative overnight announcements. On the other hand, at this market there is insufficient time for a position which targets at the profits increase and, simultaneously, more commission cost because trades are more frequent. For that reason, most of the traders prefer the one day ahead market, which is more safe for the commodity

transactions. Ewa Lazarczyk, (2016), at her working paper about the market news and its impact on the electricity markets, reports the explanation of the short-term premia between the day ahead and the intraday prices from the macro news.

At this point, by the ending of the literature review, it would be useful to be noted the way that operates the wholesale energy market at the United States of America. According to the Federal Energy Regulatory Commission (FERC), (www.ferc.gov) , which has the leading role for the reliable, efficient and sustainable energy supply to the consumers, there are ten different wholesale energy markets at the whole country. The ten ISOs (Independent System Operators), are responsible for the system operation and management at their regions and, generally, for the power supply to the retail customers. Owning the generation, the transmission and the distribution systems, the utilities at these power markets are characterized as vertically integrated. The same source states that the transmission system is operated by the ISOs independently of the wholesale market participants. Furthermore, is noted the commission's encouragement to the utilities to join regional transmission organizations (RTOs). The target of that movement would be the better transmission systems operation under equitable procedures.

There are many differences between the wholesale energy markets and the traditional financial markets and it would be false to try to connect the two terms above. To understand the discrepancy, it is enough a comparison between the electricity trade and financial asset, like bonds or equities. The main problem at the nature of trading electricity is the store inability. Electric power is produced and consumed instantly, thus demand and supply must be balanced in real time. Due to that problem, the electricity market has significant differences in comparison with other financial markets. Moreover, in contrast to the common capital markets, at which the access is available for everyone, the wholesale electricity trading has access restrictions. Although it is an open market, the technical knowledge requires a lot of experience and keep many traders away. In addition, except from technicalities, potential traders should show strong financial background for their access.

The wholesale power trade in US is accomplished through bilateral transactions. In the electricity markets, a bilateral contract is an agreement between a potential buyer and a seller. Both, desire to exchange electricity or related products, for a specified period of time, at the most suitable and profitable price for each one. The bilateral trading system is being preferred at the United States, contrary to the majority of the European countries who use the “mandatory pool” or the “nord pool”.

However, Hausman et al., (2008), at their report about the bilateral contracting in deregulated electricity markets, state that the RTOs failed to create competitive and conducive bilateral contracting environment for the consumers.

Data and Methodology

For the investigation about the impact of macroeconomic announcements at the electricity prices, are used data which have been obtained from Bloomberg Database. According to www.bloomberg.com, Bloomberg is an online database in which are provided current and historical datasets about commodities, derivatives, equities, fixed income and foreign exchange.

The data set used at this dissertation topic, consists of daily one day ahead electricity prices (USD), from January 1, 2011, through September 19, 2016 (2088 observations). The data set' prices regard the New York Independent System Operator (NYISO), which is one of the ten different wholesale electricity markets in the USA. NYISO was authorized in 1998 by FERC and launched in 1999. The figure below, (Figure 4), depicts the evolution of the electricity prices (USD) at the wholesale market in New York.

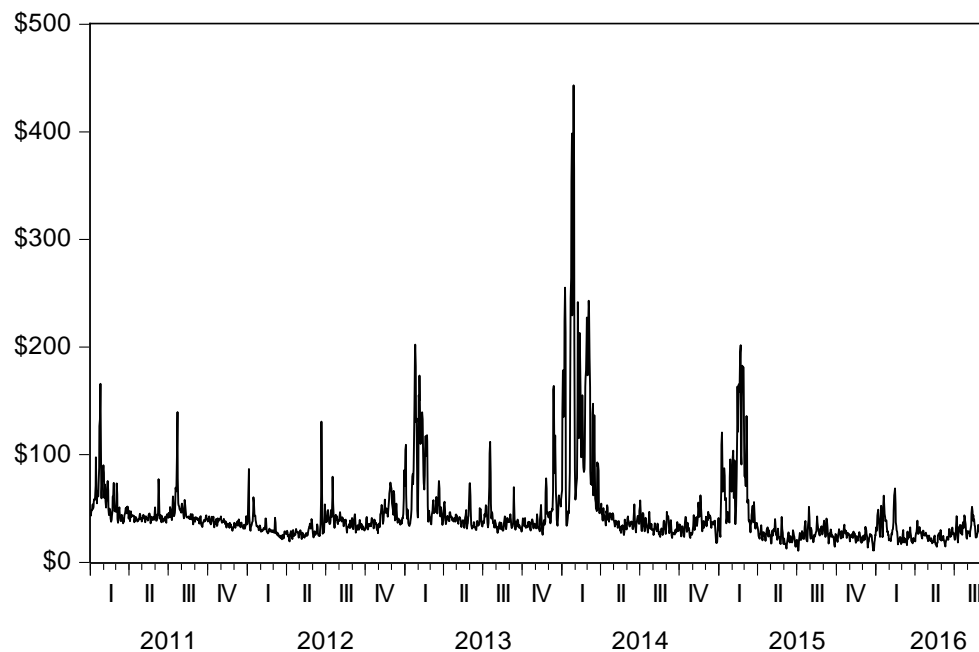


Figure 4: NYISO one day ahead electricity prices (\$/MWh), (2011-2016)

From the figure above (Figure 4), it is obvious the existence of a spike at the wholesale electricity price on January 2014, when the price exceeded the 400 USD per megawatt-hour. According to a report from the New York Independent System Operator, in early January 2014 New York set a new winter peak at the electricity demand due to extreme weather conditions. The same source notes that the increased energy demand stressed the natural gas system, which is responsible for the half of the electric generating capacity in New York, while, simultaneously, it was observed a dramatic increase in the cost of natural gas. As a result, in January 2014 were produced spikes in electricity prices, since wholesale prices are directly influenced by the cost of the fuels used by power plants to meet the demand.

The basic features, providing simple summaries about the sample of the data set, are presented at the tables below. Both Table 1 and Table 2, present the descriptive statistics of the electricity prices and their log differences, respectively.

Mean	44.01
Standard Error	0.76
Median	36.31
Standard Deviation	35.06
Sample Variance	1229.47
Kurtosis	32.95
Skewness	4.83

Table 1: Descriptive statistics for the one day ahead electricity prices

According to table 1, the kurtosis value 32.95, shows that the electricity prices do not follow the normal distribution, while the skewness value 4.83 indicates the positive skewed distribution. The following table (Table 2), presents the corresponding features for the log differences of the data set prices. The kurtosis value is 4.28, showing that the returns are

more normally distributed than the electricity prices. The negative skewness value indicates that the concentration of the returns is more on the left hand side.

Mean	-0.0002
Standard Error	0.0037
Median	-0.0072
Standard Deviation	0.1719
Sample Variance	0.0295
Kurtosis	4.2802
Skewness	-0.0377

Table 2: Descriptive statistics for the log differences
of the one day ahead electricity prices

Regarding the macroeconomic announcements and news, during this dissertation are used the FOMC meetings and the CPI and PPI indices. The annual schedule for the FOMC meetings can, easily, be found through the Board of Governors of the Federal Reserve System website (www.federalreserve.gov) , while the calendars for every year about the CPI and the PPI news releases, are taken from the Board of the labor Statistics (www.bls.gov) . In the Appendix (Section 7), there is a table, reporting the exact dates for both the FOMC meetings and the CPI and PPI news.

The methodology which is applied during this dissertation, as has, already, been mentioned at the literature review, is the same that many inventors use at their working papers. [Nikkinen and Sahlström, (2004); Chen and Clements, (2007); Cai et al., (2009); Hardouvelis, (1987); Fleming and Remolona, (1999); Barnhart, (1989)]. The macroeconomic announcements impact on the electricity prices, is examined applying an ordinary least squares model.

As a dependent variable (y), is used the logarithmic differences of the one day ahead electricity prices as it seems below

$$y_{jt} = \ln P_t - \ln P_{(t-1)} \quad (\text{eq.2})$$

, which is the logarithmic difference between the price at day t, P_t and the corresponding price at the previous day, $P_{(t-1)}$.

As an independent variable (x), is used a dummy variable D_{kt} . This dummy takes the value 1 the day t that there is a macroeconomic announcement and the value 0 otherwise.

$$D_{kt} = \begin{cases} 1 \\ 0 \end{cases}, \begin{cases} \text{if } t \in I \\ \text{if } t \notin I \end{cases} \quad (\text{eq.3})$$

, where I represents the whole days that there is at least one macroeconomic announcement (FOMC meetings, CPI and PPI news).

This methodology is, widely, applied by scientists all over the world who want to examine the effects of the macroeconomic news at the financial indices and assets. Donders and Vorst, (1996), Onan et al., (2014), Nikkinen and Sahlstrom, (2004), Andritzky et al., (2007), Belgacem et al., (2014), Sarri, (2015), Chen and Clement, (2007), Cai et al., (2009), Markellos and Psychoyios, use this dummy variable procession to import the announcement days at their working papers.

Thus, the regression model which is used at this dissertation topic, is described from the following formula

$$\ln \left(\frac{P_t}{P_{(t-1)}} \right) = a + bD_{kt} + \varepsilon_t \quad (\text{eq.4})$$

, where

$\ln\left(\frac{P_t}{P_{(t-1)}}\right)$ the logarithmic differences of the one day ahead electricity prices,

a the intercept of the regression,

bD_{kt} the dummy variable with the intercept

and ε_t the residuals.

A significant step before running the OLS regression, is the examination about the existence of seasonal components. Seasonality is a possible characteristic of the high frequency time series data, like this which is used during this dissertation. The higher the frequency of an economic time series, the more likely the display of seasonal patterns. To avoid misleading signals which lead to inappropriate results, it is very important the research for seasonal components at the data set and the deduction before every econometric calculation.

A simple method to test for seasonal patterns at the data set constitutes the regression analysis using dummy variables. Philip Hans Franses, (1991) applied this methodology at the investigation about seasonality, non-stationarity and forecasting of monthly time series. He runs an autoregressive moving average model for a dependent variable, in first differences, a constant and eleven (11) seasonal dummy variables. Ewa Lazarczyk, (2016), examining market-specific news effect on the short-term forward premia on the Nordic electricity market, run an OLS regression including seven dummy variables in order to capture weekly seasonality. In addition, Higgs and Worthington, (2008), at their research about the Australian wholesale electricity market, follow the same methodology, importing seven (7) dummy variables for the week days and eleven (11) dummies for each month (it is noted that one month is the reference category).

Thus, it is obvious that this methodology, mentioned above, is, widely, accepted by many researchers and constitutes a successful way for seasonality test. The model which is

used at this dissertation, consists of an ordinary least squared regression between the log differences of the one day ahead electricity prices and eleven (11) dummy variables, without a constant term. Seven (7) dummy variables are included for the week days, while the rest four (4) dummies represent the quarters of the year. At last but not least, Lucia and Schwartz, (2002), apply this methodology at their working paper and, finally, note that the dummy variable approach is generally preferred for seasonality test, as it is intuitive and easy to interpret.

The regression analysis, researching for seasonal patterns at the NYISO data set, is described from the following formula:

$$\ln\left(\frac{P_t}{P_{(t-1)}}\right) = \sum_{i=1}^7 a_i D_i + \sum_{k=1}^4 b_k Q_k + e_j \quad (\text{eq.5})$$

, where

$\ln\left(\frac{P_t}{P_{(t-1)}}\right)$ the logarithmic differences of the one day ahead electricity prices,

D_i the dummy variable regarding the week days,

Q_k the dummy variable representing the quarters of the year

and e_j the residuals.

Running the regression (eq.5), at the 95% of significance level, occur the results which are presented at the next table, (Table 3). P-values and t-statistics are the amounts that indicate the existence or not of a seasonal pattern at the logarithmic differences of the one day ahead electricity prices.

The p-value for each imported dummy variable examines the null hypothesis that the corresponding coefficient is equal to zero and has no effect on the dependent variable. A

p-value lower than alpha value, which is equal to 0.05 at the 95% of significance level, indicates that the null hypothesis can be rejected and that the independent variable has a significant impact on the dependent variable. Otherwise, a p-value greater than alpha, suggests that changes at the independent variable are not associated with changes at the dependent variable. The same interpretation is applicable at the examination of seasonality at the data set. A p-value for a dummy variable lower than 0.05 indicates the existence of seasonal patterns at daily or quarterly level.

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
D1	0.208	0.110	1.887	0.059
D2	0.057	0.110	0.520	0.603
D3	0.029	0.110	0.264	0.792
D4	0.034	0.110	0.309	0.758
D5	0.019	0.110	0.168	0.867
D6	-0.051	0.110	-0.463	0.643
D7	0.005	0.110	0.044	0.965
Q1	-0.039	0.110	-0.353	0.724
Q2	-0.048	0.110	-0.434	0.664
Q3	-0.043	0.110	-0.392	0.695
Q4	-0.042	0.110	-0.385	0.700

Table 3: Output of the OLS regression (eq.5)

at the 95% confidence level

According to the table above (table 3), it is accessible that both the seven week day dummy variables and the four quarter dummy variables are not significant, since the corresponding p-values are all greater than 0.05.

However, Knittel and Roberts, (2005), report that electricity prices are characterized by strong seasonal components at quarterly level because of the demand seasonality. For that reason, and for more safe results, becomes a further test about the existence of quarterly seasonal patterns, running the same OLS regression (eq.5) without the dummy variables which regard the weekdays. The results of this regression are presented at table 4.

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Q1	0.005	0.008	0.600	0.549
Q2	-0.005	0.007	-0.731	0.465
Q3	0.000	0.007	-0.022	0.983
Q4	0.001	0.008	0.080	0.937

Table 4: Output of the OLS regression (eq.5),
without the weekday dummies

Table 4 indicates and confirms the results from table 3, since all the quarterly dummy variables have a p-value lower than 0.05 and are not statistically significant at the 95% confidence level. Thus, can be concluded the absence of seasonal patterns at the data set used during this dissertation.

Another test, which is applied at the model before the final regression, is the White Test, using Eviews. This test examines the existence of heteroskedasticity or homoscedasticity at the error terms of the data. Homoscedasticity means that the variance of the error terms is constant. If the error terms are not characterized from constant variance, they are said to be heteroskedastic.

The null hypothesis H_0 , assumes that there is no heteroskedasticity at the error terms, while the alternative hypothesis H_1 supports that the variance of the error terms is not constant.

According to Eviews output (see Appendix), the p-value of the White Test is equal to 0.173, which is greater than 0.05. Thus, the null cannot be rejected and is concluded that the error terms are homoscedastic.

Afterwards, equation 4, which describes the OLS regression between the electricity price differences and the macroeconomic announcements, is imported on Eviews.

The null hypothesis (H_0) at this regression model, assumes that there is no impact on the one day ahead electricity prices from the macroeconomic announcements (FOMC meetings, CPI and PPI news release). On the contrary, the alternative hypothesis (H_1),

assumes that the macroeconomic announcements affect the one day ahead electricity prices.

According to Eviews output (see Appendix), the p-value for the dummy variable D_{kt} , which represents the macroeconomic announcements, is equal to 0.0428. At the 95% of significance level, alpha value is equal to 0.05. Thus, the null hypothesis H_0 is rejected, having evidence that the alternative hypothesis H_1 describes the model correct.

Conforming to this result and rejecting the null hypothesis, can be supported that the macroeconomic announcements imported to the model, influence the one day ahead electricity prices. This result is going to be analyzed at the next section.

After the regression, it is worthwhile the estimation and the examination of the logarithmic difference price volatility. For the annualized volatility, the standard deviation of a 20-day period is multiplied with the squared root of 365. The results and the volatility changes through the years are presented at the figure below, (Figure 5).

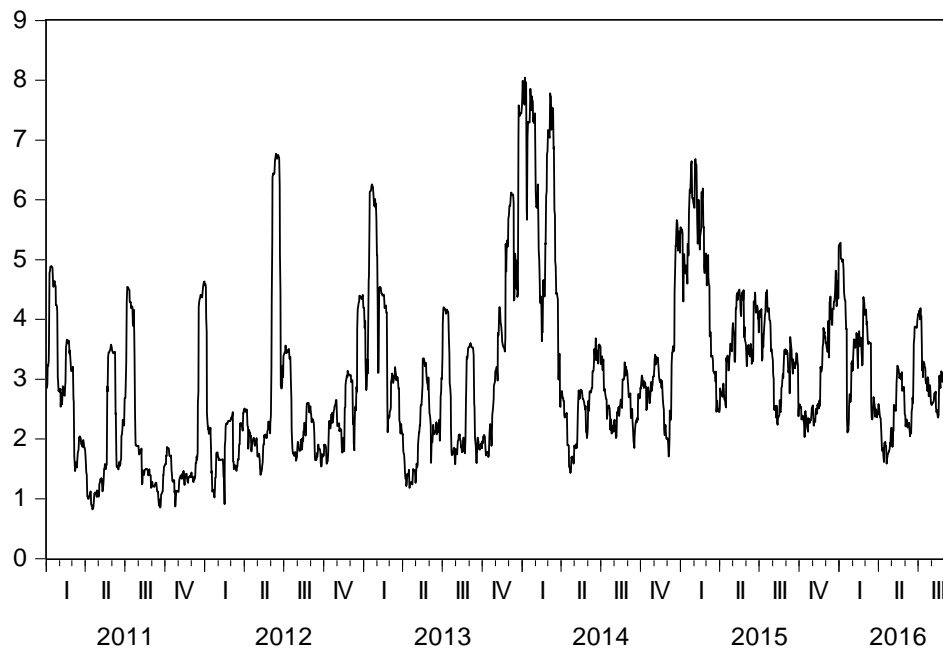


Figure 5: volatilities of the price logarithmic differences
(January 2011- September 2016)

Afterwards, it is examined the impact of the macroeconomic announcements at the volatilities of the electricity price returns. According to the literature review, which is presented at section 2, macro news have a significant effect on commodity price volatilities.

The regression analysis which examines the existence or not of impacts at the electricity price return volatilities, is described from the following equation, (eq.6).

$$P_{vol_t} = a + bD_{kt} + \varepsilon_t \quad (\text{eq.6})$$

, where

P_{vol_t} the volatility of the electricity price return at day t,

a the intercept of the regression,

bD_{kt} the dummy variable with the intercept

and ε_t the residuals.

According to Eviews output (see Appendix), the p-value for the dummy variable D_{kt} , which represents the macroeconomic announcements, is equal to 0.469. At the 95% significance level the alpha value is equal to 0.05. Thus, the null hypothesis, that the macro news has no impact on the price return volatilities, cannot be rejected, since 0.469 is greater than the alpha value. Finally, it is concluded that the volatilities are not been affected from macroeconomic news like FOMC meetings and CPI and PPI reports.

Empirical discussion

At this section, it is going to be examined if there is an association between the results and the literature review and, simultaneously, will be presented an explanation about the OLS regression output.

As it has, already, been mentioned, the main problem during the examination of the macroeconomic news impact on electricity prices, is the absence of previous scientific working papers. So far, there are many researchers who have investigated the macro news effects on commodity price like gold, silver, crude oil and gasoline, but none of them is focused on the electricity prices. For that reason, the expectations regarding the results of the research which is presented at this dissertation, is unknown.

According to the result occurred from the OLS regression analysis, there is an evidence that the macroeconomic announcements have a significant impact on the one day ahead electricity prices. However, there is not at the macroeconomic theory a direct association between the two factors. Thus, an explanation about the result is given using other macroeconomic indices, which try to connect the macro news with the wholesale electricity prices.

Firstly, the explanation starts noting that the macroeconomic announcements like CPI and PPI affect the economic growth of a country. At these two indexes, could, easily, be added the Gross Domestic Product or GDP. According to Joseph Nguyen and Aaron Levitt, (www.investopedia.com), CPI, PPI and GDP indices are, simultaneously, responsible for significant changes at the Euro and the British pound and, also, have a severe effect at the USA stock market. Thus, it is obvious, that the macroeconomic announcements about these indices have an impact on the economic growth of a country.

In addition, Ikegami and Wang, (2016), at their working paper about the relationship between electricity consumption and real GDP, report a unidirectional association between the GDP and the electricity consumption. The two researchers investigate the financial markets in Japan and Germany and conclude that the consumption follows the

fluctuations of the GDP. Moreover, they note that at the Japanese financial market, an increase at the electricity consumption is a significant evidence of the economic growth of the country. Thus, for a developed country like Germany and Japan, an increase at the GDP can be followed from an increase at the electricity consumption.

As has, already, been mentioned at the literature review, both Knitel and Roberts, (2005) and Werner, (2014), at their working papers, support that the electricity prices are high correlated with the electricity demand. The behavior of the wholesale prices seems to follow the demand trend, with higher prices the high demand periods.

According to the previous rationale, using the two researches above, the macroeconomic theory and considering that the electricity demand has the same trend with the electricity consumption, is given the explanation about the result from the OLS regression. At last but not least, it is concluded that the macroeconomic announcements affect the economic growth, which has as a result an impact at the electricity demand and finally at the electricity prices.

The last part of this section regards the volatilities of the electricity price logarithmic differences. The OLS regression (equation 6) indicates that the volatilities are not affected from the macroeconomic news. That result is in contrast with the literature review (Section 2), in which is stated an association between the announcements and the commodity volatilities. Thus, it could be noted that the electricity price volatilities have a different behavior in comparison with the volatilities from commodities. However, figure 5 confirms the existence of high values at the electricity price volatilities, which are, always, greater than 100%.

Conclusion

The absence of previous working papers focused on the electricity prices was the main problem from the start of this thesis. During these months, when was investigated the impact of macroeconomic announcements on electricity prices, me and my supervisor Dr. D. Psychoyios were working hard to examine if there is an association between the macroeconomic theory and a commodity like electricity. The literature review states that there are discrepancies between the electricity market and the markets about the rest of the commodities and the financial assets. The relative youth of electricity market restructuring in combination with the problem about the power storage, differentiate the electricity from commodities like crude oil, natural gas, gold and silver.

According to the results, there is an evidence that macroeconomic news has a significant influence at the one day ahead electricity prices. However, there is not at the macroeconomic theory a directly relationship between them. A possible explanation about the effect is given using as intermediary factors the electricity consumption and demand. The macroeconomic announcements affect the economic growth of a country which has as a result an increase at the consumption of electricity, while the electricity demand seems to be high correlated with the wholesale electricity prices. Thus, it is concluded that a macro news about the CPI or the PPI of a developed economy could have an effect at the wholesale electricity pricing.

Finally, the examination has different results about the news impact on price volatilities. Although at the literature review is stated the announcements effect on commodity volatilities, the regression analysis cannot meet the expectations. However, the results confirm the existence of high volatilities at the electricity prices in contrast to crude oil and natural gas prices.

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Appendix

Macroeconomic Announcements Schedules:

- FOMC Meetings

2016	2015	2014	2013	2012	2011
January 27	January 28	January 29	January 30	January 25	January 26
March 16	March 18	March 4&19	March 20	March 13	March 15
April 27	April 29	April 30	May 1	April 25	April 27
June 15	June 29	June 18	June 19	June 20	June 22
July 27	July 29	July 30	July 31	August 1	August 1&9
September 21	September 17	September 17	September 18	September 13	September 21
November 2	October 28	October 29	October 16&30	October 24	November 2&28
December 14	December 16	December 17	December 18	December 12	December 13

Source: www.federalreserve.gov

- PPI News releases

2016	2015	2014	2013	2012	2011
-	December 11	December 12	December 13	December 13	December 15
-	November 13	November 18	November 21	November 14	November 15
-	October 14	October 15	October 29	October 12	October 18
September 15	September 11	September 16	September 13	September 13	September 14
August 12	August 14	August 15	August 14	August 14	August 17
July 14	July 15	July 16	July 12	July 13	July 14
June 15	June 12	June 13	June 14	June 13	June 14

May 13	May 14	May 14	May 15	May 11	May 12
April 13	April 14	April 11	April 12	April 12	April 14
March 15	March 13	March 14	March 14	March 15	March 16
February 17	February 18	February 19	February 20	February 16	February 16
January 15	January 15	January 15	January 15	January 18	January 13

Source: www.bls.gov

- CPI News releases

2016	2015	2014	2013	2012	2011
-	December 15	December 17	December 17	December 14	December 16
-	November 17	November 20	November 20	November 15	November 16
-	October 15	October 22	October 30	October 16	October 19
-	September 16	September 17	September 17	September 14	September 15
August 16	August 19	August 19	August 15	August 15	August 18
July 15	July 17	July 22	July 16	July 17	July 15
June 16	June 18	June 17	June 18	June 14	June 15
May 17	May 22	May 15	May 16	May 15	May 13
April 14	April 17	April 15	April 16	April 13	April 15
March 16	March 24	March 18	March 15	March 16	March 17
February 19	February 26	February 20	February 21	February 17	February 17
January 20	January 16	January 16	January 16	January 19	January 14

Source: www.bls.gov

EvIEWS Outputs:

- White Test

Heteroskedasticity Test: White

F-statistic	1.853475	Prob. F(1,2086)	0.1735
Obs*R-squared	1.853605	Prob. Chi-Square(1)	0.1734
Scaled explained SS	5.791420	Prob. Chi-Square(1)	0.0161

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 12/18/16 Time: 18:22

Sample: 1/01/2011 9/18/2016

Included observations: 2088

Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030153	0.001689	17.85630	0.0000
DUMMY^2	-0.007830	0.005751	-1.361424	0.1735
R-squared	0.000888	Mean dependent var		0.029478
Adjusted R-squared	0.000409	S.D. dependent var		0.073777
S.E. of regression	0.073762	Akaike info criterion		-2.374990
Sum squared resid	11.34957	Schwarz criterion		-2.369583
Log likelihood	2481.489	Hannan-Quinn criter.		-2.373009
F-statistic	1.853475	Durbin-Watson stat		1.576571
Prob(F-statistic)	0.173527			

- OLS regression

(Electricity Price logarithmic differences–Macroeconomic Announcements)

Dependent Variable: EL_PRICE

Method: Least Squares

Date: 12/18/16 Time: 18:29

Sample (adjusted): 1/01/2011 9/18/2016

Included observations: 2088 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DUMMY	-0.027152	0.013394	-2.027234	0.0428
C	0.002145	0.003933	0.545512	0.5855
R-squared	0.001966	Mean dependent var		-0.000195
Adjusted R-squared	0.001488	S.D. dependent var		0.171903
S.E. of regression	0.171775	Akaike info criterion		-0.684309
Sum squared resid	61.55066	Schwarz criterion		-0.678903
Log likelihood	716.4182	Hannan-Quinn criter.		-0.682328
F-statistic	4.109677	Durbin-Watson stat		1.610973
Prob(F-statistic)	0.042765			

- OLS regression

(Volatilities of the price logarithmic differences – Macroeconomic Announcements)

Dependent Variable: VOLATILITIES
 Method: Least Squares
 Date: 12/18/16 Time: 18:32
 Sample (adjusted): 1/01/2011 8/30/2016
 Included observations: 2069 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DUMMY	-0.080420	0.111225	-0.723038	0.4697
C	3.043778	0.032715	93.03860	0.0000
R-squared	0.000253	Mean dependent var	3.036821	
Adjusted R-squared	-0.000231	S.D. dependent var	1.422102	
S.E. of regression	1.422266	Akaike info criterion	3.543346	
Sum squared resid	4181.210	Schwarz criterion	3.548793	
Log likelihood	-3663.591	Hannan-Quinn criter.	3.545342	
F-statistic	0.522784	Durbin-Watson stat	0.030923	
Prob(F-statistic)	0.469738			